A REPORT

ON

A PRELIMINARY STUDY OF THE FORAGING BEHAVIOR OF STARLINGS IN CENTRAL OHIO FARM AREAS

Prepared for

The Honors Program Committee
The School of Natural Resources
The Ohio State University
Columbus, Ohio

by

Barbara L. Walinski
May 8, 1978

ABSTRACT

Differences occurred in the foraging behavior of the starling (*Sturnus vulgaris*) relative to foraging sites and domestic animal associations. Starlings select insects over vegetative matter. When insects become scarce in winter months, starlings change from flock-foraging behavior to foraging in farm yards where livestock stir up insects from the soil. Starlings will follow pigs when insects are forced deeper into the soil by frost. Pigs root up insects, so starlings have a supply of insect food in winter months that would otherwise limit their diet to vegetative matter. This information may be pertinent to the wildlife manager as he/she revises methods for controlling starling populations. This factor is a sufficient reasons for starlings to stay in farm areas. Further research can be conducted to find a means to control the starling by controlling the food supply. Considerations for further research are presented, with the role of the $E/(T_h + T_s)$ value (Charnov, 1976) discussed.

TABLE OF CONTENTS

I. INTRODUCTION

The starling (Sturnus vulgaris) has become such a problem in cities and farms that new methods must be devised to control them, or old methods must be improved (Dolbeer et al., 1978). Every animal has four basic living requirements: food, water, cover (shelter), and living space. If any one of these factors can be controlled, then the animal can also be directly controlled. In Ohio, I have studied the starlings foraging efficiency with results that may be significant in conducting further research to devise or revise control methods.

The starling occupies and thrives in many environments. The starling appears to be adapted so that any environment suits its needs; this adaptation is exemplified by the rapid spread the starling has made across the United States after its introduction in 1891 (Wing, 1943). Although the starling's food and feeding characteristics have been thoroughly examined in the United States (Kalmback and Gabrielson, 1921; Linsey, 1939), most of this work was done prior to 1960 and did not include studies on foraging behavior patterns or feeding efficiencies.

Dolbeer et al. (1978) have found starlings in livestock feedlots more from November to December and less in wheat lots during this period.

In this experiment, I attempted to examine the differences in foraging behavior relative to foraging sites and domestic animal associations.

In warm months, when insects are abundant, starlings can forage in many locations and find sufficient food items. As the temperature drops in autumn months, fewer and fewer insects are found. Observations have been made of starlings following cows (Forbush, 1927). Presumably the cows kick up insects from the soil (Grubb, 1976; Wilson, 1975; and Heatowle, 1965), but in these colder months insects are driven deeper into the soil than a cow's hoof can penetrate. Starlings follow pigs in fall and winter (Shields, personal communication); pigs root (shove their snouts down into the soil and throw up the dirt leaving a 6-12 inch hole in the dirt) deep enough into the soil to bring insects and food items to the surface. By following pigs, the starlings may be able to find insects to eat even when the frost has driven the insects underground.

The goal of this experiment is to serve as a preliminary study to provide information about aspects of foraging behavior patterns in terms of feeding efficiencies in farm communities. With this new information added to known factors, it may facilitate further research that can aid in devising effective management practices for starling populations in farm communities. Optimal foraging models are discussed as means to extending this information to future studies.

II. METHODS

From September to December 1977, I watched birds in a farmer's pig-yard located in Wilmington, Ohio county and in cow-yards and fields at the Ohio State University dairy barns. I watched only those starlings foraging in one of the above-mentioned patches. I conducted the observations between 7 a.m. to 12 p.m. and 3 p.m. to 5 p.m. (Eastern Standard Time). The sites were chosen by the availability of a parking space nearby: starlings are easily frightened, but they seemed to ignore the presence of a car. In each situation--starlings foraging in flocks, with cows, or with pigs--the same data was taken.

Individual birds were followed until they stopped foraging. The data were taken in three segments for each case (starlings in flocks, with cows, and with pigs), those segments being (1) pecking data, and (2) bout data, with (3) conditions recorded for both.

Pecking Rate

For the first segment of observation data, the first person in the team observed a starling foraging, counted the total number of pecks at the ground the starling made and on a stopwatch recorded the time the bird spent pecking during a foraging sequence. At the end of each observation sequence, the first person also estimated the distance the starling traveled. The second person in the team timed the duration of the observation on a second stopwatch, and recorded the data reported by the first person. From this data, I calculated the time spent not foraging and the average number of pecks per unit time.

Bout Rate

For the second segment of data, we observed bouts. A bout is the time a starling pecked consecutively without putting its head up, regardless of the number of pecks made. The first person recorded the bout time on a stopwatch and called out the number of pecks the starling made in each bout, while the second person recorded the numbers called, and timed the duration of the foraging sequence on a second stopwatch. The first person estimated the distance the observed starling traveled during the observation period. From this data, I calculated the average number of pecks per bout, the average duration of a bout, and the average number of bouts per unit time.

The above data was analyzed using the t-test.

Conditions Recorded

Immediately following each observation, I recorded the time of day, the temperature, the cloud cover, the relative amount of wind, the number of birds in the flock, and the other bird species present. The person observing the starling estimated its distance from the nearest starling, and in the cases of starlings foraging with cows and with pigs, we also estimated the distance between the starling and the animal. I also recorded the number of cows or pigs in the yard and their behavior (grazing, rooting, etc.).

It has been determined that winter weather has an effect on the foraging behavior of birds (Grubb, 1975), but the amount of data I have collected is not sufficient to rule out this effect as a variable. In future studies, more data will need to be taken for a given temperature range/wind velocity, and then sightings will have to be grouped together in order to hold these variables constant.

III. RESULTS

I studied the feeding efficiencies in terms of pecking rate and bout rate of starlings in the following three situations: foraging in flocks, foraging with cows, and foraging with pigs. In neither of the two later situations did the starlings seem disturbed by the presence of the cows or pigs, but the starlings did respond to the movement of either of the two animals. Starlings flew to trees or fences when cows called and followed pigs as they rooted in a field. Unless the starlings were foraging near the animals, they did not actively pursue nor avoid contact with these animals.

Patch Choice

Flocks flew randomly between open fields and livestock yards when disturbed by the observers' or farmers' activities in September and early October. The starlings appeared to show no preference for any particular situation of the three at this time.(found with flocks 66% of the time flocks were observed, found with cows 66% of the time starlings with cows were observed, and found with pigs 50% of the time starlings with pigs were observed). In late October through December, however, among the number of observations taken the flocks were found with increasing frequency in livestock yards, especially pig-yards with pigs present (found in flocks 66% of the time, with cows 52% of the time, and with pigs 79% of the time).

Pecking Rate

There was no significant difference among the total number of pecks per total time (of each observation) in any of the three situations. The average number of pecks per bout did vary significantly ($p < .02$) between starlings foraging in flocks and those foraging with pigs. The number of pecks per bout for starlings foraging with pigs was lower than the value for flock-foraging starlings (Table 1).

Bout Rate

Bout rate varied in all three situations. Average bout time was significantly different between starlings foraging in flocks and starlings foraging with pigs ($p < .05$), the latter having the lower value. Starlings foraging with cows showed a significantly different average number of bouts per second than starlings foraging with pigs ($p < .05$); those starlings foraging with pigs averaging more bouts per time. The average bout time for starlings foraging with cows averaged higher than that for starlings foraging with pigs ($p < .08$). The average number of bouts per time varied between starlings in flocks and with cows ($p < .1$), the average being higher for starlings in flocks. The last two p-values are given because biological significance does not always coincide with statistical significance ($p < .05$).

Spatial Variation and Movement

(1) Starlings foraging in flocks showed the closest interindividual distance ($\bar{X} = 15$ cm), but traveled the greatest distance per time (5.4 cm/sec).

(2) The average distance between a cow and a starling foraging with it was 100 cm. Interindividual distance between starlings varied greatly from solitary birds to ten or more birds 15 cm apart. The distance a starling traveled while foraging with cows averaged 2.5 cm/sec.

(3) Starlings foraging with pigs commonly foraged independently of other birds (> 150 cm), but followed the pigs at an average of 75 cm searching the rooted areas as the pig moved away. These birds traveled the shortest distance of the three cases averaging 1 cm/sec. In most cases, the starling moved as the pig moved but remained some distance behind (Table 2).

Sample Size

Data was not divided according to varying environmental conditions because of small sample size under any particular set of conditions. This is a short-coming since weather has been shown to effect foraging rates (Grubb, 1975).

The sample size for data of starlings foraging with cows was relatively small. Most of the starlings observed in feedlots with cows were farther than 500 cm from the cow, and this was arbitrarily regarded as not foraging with the cow. Also, if aggressive behavior occurred during an observation the data was discarded because pecks per time and bouts per time were calculated from a total observation time which required no interruptions.

IV. DISCUSSION

Royama (1970) discussed foraging by profitability for the great tit (Parus major (L.)) where birds should forage only for prey items which were profitable in terms of the intake of biomass in a given time spent hunting. Several authors have discussed optimal foraging in terms of the net energy a predator ingests for a given time spent capturing the prey (Emlen, 1966; Schoener, 1971; MacArthur and Pianka, 1966). According to these authors, a bird who is optimally foraging is maximizing its net energy intake. The theory of optimal foraging assumes all animals should forage optimally (Pyke et al., 1977). MacArthur and Pianka (1966) relate optimal foraging to the ratio of ε/h, where ε is the energy intake and h is the handling time. Charnov (1976) restates this value as $E/(T_h + T_s)$, where T_h is handling time an T_s is time spent searching for the prey item.

Krebs et al. (1972) addressed the advantages of flocking by enhancing feeding efficiencies in two ways: (1) by directly increasing the availability of food (flushing by flock members), and in the case of Cattle Egrets (Bulbuleus ibis), it is the cow herds that flush the insects (Heatwole, 1965; Grubb, 1976); and (2) by learning of potential food sources from other flock members. In each of the observational situations presented in this paper, a flock of starlings was in the area studied (the observed starlings were members of a flock), but variations in foraging behavior occurred in the different situations.

The three observational situations were starlings foraging in flocks, starlings foraging with cows, and starlings foraging with pigs. The differences in foraging behavior were measured in terms of pecking rate, bout rate and distance traveled. While these parameters do not describe the $E/(T_h + T_s)$ value *per se*, the pecking rate, bout rate, and distance traveled were examined as indirect measurements of feeding efficiencies, with the concept of $E/(T_h + T_s)$ value maximization in mind. Future studies must address this concept (see Recommendations). Assuming that starlings forage optimally (Pyke et al., 1977), then in each of these three situations the $E/(T_h + T_s)$ values should be maximized. Depending upon the relative availabilities of prey items in these patches at any given time, the starlings should associate these prey items with the patches in which they occur (field foraging in flocks, in barnyards with cows, or with pigs). MacArthur and Pianka (1966) discussed patch choice by foraging birds. By decreasing the handling and searching times, the $E/(T_h + T_s)$ value is increased. Foraging should, therefore, occur in the patch where the prey items with the highest $E/(T_h + T_s)$ values occur.

A preliminary study such as this cannot provide enough support for anything more than speculation. It does provide, however, firm ground on which to base further research aimed at answering the questions raised herein.

The starling's pecking rate did not vary in total number of pecks per second for the three situations, but the pecking rate did vary significantly with the number of pecks per bout. Flock-foraging starlings pecked significantly more than starlings foraging with pigs in terms of number of pecks per bout and the average bout time. Several optimal-foraging models assume search speed to be constant (Emlen, 1965; Schoener, 1971; and MacArthur and Pianka, 1966). From this, then, it appears starlings in flocks are expending more energy than they would by following pigs. The average distance traveled per second is also much farther for flock-foraging starlings than pig-following starlings. Assuming the starlings are successful with each peck, then the higher pecking rate and higher expenditure of energy could mean (1) that there was a high density of prey in the optimal range of $E/(T_h + T_s)$ values, or (2) that the birds must peck at this rate to achieve high $E/(T_h + T_s)$ values because there is a low density of optimal prey items and a higher density of less preferred items. Goss-Custard (1977) found that for Redshank (Tringa totanus) the feeding rate on large worms (optimal prey items) depended mainly on their density in the mud. Feeding rate on small worms (sub-optimal prey items) was more influenced by the biomass ingested from large worms than their own density so that small worms were only taken frequently when large ones were scarce. Charnov (1976) discussed the measure of the rate of food intake by the foraging animal as food in the gut. To achieve the desired intake of food, a starling foraging with a high pecking rate and long bout time would be ingesting relatively small prey items. Starlings foraging with pigs, then, that peck less frequently and in shorter bouts should be ingesting relatively larger prey items or prey items with higher caloric value.

After a pig has rooted, prey items should be more obvious in the hole rooted than on the undisturbed surface. The expenditure of energy in prey capture would be lower by decreasing search time. The average number of bouts per time is lowest for starlings following pigs which should mean that less energy has to be used to find and capture prey items. Low pecking rate could mean that the bird has to expend less energy by pecking less often to ingest enough prey items to obtain a large biomass (caloric or nutritional intake, etc.).

Royama (1970) stated that it isn't the density of prey that is important to the predator, but the profitability in terms of biomass intake in a given time spent hunting.

The pig yard was not the only alternative for starlings because other field types were available to them in the immediate vicinity. If the $(T_h + T_s)$ value was lowered for the starling by following pigs, then the $E/(T_h + T_s)$ value would be increased (whether or not E is increased). The profitability of prey items for starlings following pigs may account for this behavior.

In agreement with Dolbeer et al. (1978) this study also shows increased use of feedlots (as opposed to wheat fields) as colder temperatures set in from September to December. It seems that the relative abundance of insects in the different situations would change with the seasonal changes; frost would drive insects deeper into the soil and reduce their availability above ground. At this time, the rooting activity of the pigs would increase the availability of food items relative to other fields. A more extensive study should examine the correctness of this assumption. Furthermore, weather-dependent foraging behavior must also be considered (Grubb, 1975).

The results of the foraging behavior of starlings with cows was intermediate between the results of flock-foraging behavior and pig-following foraging behavior. Because the major differences in behavior occurred between the latter two situations, and because of the relatively small amount of data collected on starlings foraging with cows I limited the discussion on this data.

In conclusion, if the pig-yard is indeed the most profitable patch in terms of providing optimal prey, especially in autumn and winter months, then this theory should be further examined and considered in revising management methods for the control of starling populations in farm communities.

V. RECOMMENDATIONS

More Extensive Data Collection

This study intends to supply the initial information that is needed in order to implement further research. The methods described herein proved to be suitable, but further research must be undertaken to collect a more extensive range and amount of data. To devise a control technique for the starling based on the findings of this report, a wider range of farm areas should be studied. With a greater amount of data available from further studies, mathematical models (MacArthur and Pianka, 1966; Schoener, 1971) could be employed to give more complete information concerning the farm as a food source for starlings.

Stomach Content and Soil Analyses

The assumptions made in this text must be studied further to determine the most important factors in the foraging behavior of starlings. This paper is only a beginning. The most preferred food item can easily be identified through stomach-content analyses and soil inventories. The caloric values for each item must also be determined to calculate net energy intake. The soil inventories will tell what food items are available to the starlings and the relative abundance of each item. The stomach-content analyses will show which items the starlings choose, given the type of items available (Coleman, 1977). The identification of these factors could then be used to access the role of energy intake maximization in terms of caloric values of the prey items.

VI. ACKNOWLEDGMENTS

I would like to thank W. M. Shields for his assistance and for providing the original observation on which this study was based. And I also extend my appreciation to Joel Schwankl for his assistance in the field and comments for the improvement of an earlier version of this paper.

LITERATURE CITED

Charnov, E. L. 1976. Optimal foraging: attack strategy of a mantid. Amer. Nat., 110:141-151.

Coleman, J. D. 1977. The foods and feeding of starlings in Canterbury. Proceedings of the New Zealand Ecological Society, 24:94-109.

Dolbeer, R. A., P. P. Woronecki, A. R. Stickley, Jr., and S. B. White. 1978. Agricultural impact of a winter population of blackbirds and starlings. The Wilson Bulletin, 90:31-42.

Emlen, J. M. 1966. The role of time and energy in food preference. Am. Nat., 100:611-617.

Forbush, E. H. 1927. Birds of Massachusetts and other New England States, pt. 2. Land birds from bob-whites to grackles. In A. C. Bent 1950. Life histories of North American wagtails, shrikes, vireos, and their allies. Smithsonian Institution, United States National Museum Bulletin, 197:182-241.

Goss-Custard, J. D. 1977. Optimal foraging and the size selection of worms by the redshank, Tringa totanus, in the field. Anim. Behav., 25:10-29.

Grubb, T. C., Jr. 1975. Weather-dependent foraging behavior of some birds wintering in a deciduous woodland. Condor, 77:175-182.

Grubb, T. C., Jr. 1976. Adaptiveness of foraging in the cattle egret. The Wilson Bulletin, 88:145-148.

Heatwole, H. 1965. Some aspects of the association of cattle egrets with cattle. Anim. Behav., 13(1):79-83.

Kalmbach, E. R., and I. N. Gabrielson. 1921. Economic value of the starling in the United States. U.S. Department of Agriculture. Bulletin No. 868.

Krebs, J. R., M. H. MacRoberts, and J. M. Cullen. 1972. Flocking and feeding in the great tit: and experimental study. Ibis, 114: 507-530.

Linsey, A. A. 1939. Food of the starling in Central New York State. The Wilson Bulletin, 51(3):176-82.

MacArthur, R. H., and E. R. Pianka. 1966. On optimal use of a patchy environment. Am. Nat., 100:603-609.

Pyke, G. H., H. R. Pulliam, and E. L. Charnov. 1977. Optimal foraging: A selective review of theory and tests. Quart. Rev. Biol., 52 (2):137-154.

Royama, T. 1970. Factors governing the hunting behavior and selection of food by the great tit (Parus major L.). J. Anim. Ecol., 39: 619-668.

Schoener, T. W. 1971. Theory of feeding strategies. Annu. Rev. Ecol. Syst., 2:369-404.

Wilson, E. O. 1975. Sociobiology: the new synthesis. Belknap (Harvard) Press, Cambridge. pp. 52-53.

Wing, L. 1943. Spread of the starling and english sparrow. Auk, 60: 74-87.

TABLE 1

The foraging behavior in the three observational situations (columns) measured in terms of pecking rates and bout rates (rows).

	Starlings foraging in flocks	Starlings foraging with cows	Starlings foraging with pigs
Total # of pecks/sec	0.637	0.627	0.514
Average bout time (sec)	7.39	6.76	4.16
# of pecks/bout	7.12	6.40	3.43
Average # of bouts/sec	0.181	0.102	0.151

TABLE 2

Spatial variations and movements (rows) of three observational situations (columns).

	Starlings foraging in flocks	Starlings foraging with cows	Starlings foraging with pigs
Distance traveled/sec	5.4 cm/sec	2.5 cm/sec	1.0 cm/sec
Average Intraspecies distance	15 cm	15-100 cm	> 150 cm
Average Interspecies distance	---	100 cm	75 cm

MEMORANDA

December 7, 1977
(date submitted)

To: Robert E. Henne, Secretary
School of Natural Resources

From: Barbara L. Walinski

Subject: FORAGING BEHAVIOR OF STARLINGS (*Sturnus vulgaris*)

The concern starlings have generated and a new observation concerning their foraging behavior prompt me to submit this proposal as my Natural Resources 693.02 Honors project.

Purpose

Form a wildlife-management point of view, it is necessary to know as much as possible about an animal's physical make-up as well as its behavioral patterns before choosing the proper management techniques to control it.

The starling (*Sturnus vulgaris*) is an introduced species in the United States from England. Since the release in 1891 of 100 starlings in Central Park, New York, they have spread south into the Southern states, north into lower Canada, and as far west as the Pacific coast. The starling's ability to thrive under many conditions and in varying environments has allowed it to populate almost any area. And the starling is still spreading its range, with no apparent limit.

The starling has become a nuisance in cities and on farms throughout the United States. Many people have taken action to control the starling population, but without complete success. This lack of success indicates that a re-evaluation of the situation is necessary.

Perhaps a further understanding of the starling's behavior patterns (since the physiology of birds is well researched) will furnish the knowledge necessary to successfully control the starling. One such behavior is the foraging behavior of starlings. Of the research published on the starling, little has been reported on the autumn and winter feeding of these insectivorous birds. Because starlings eat mostly insects, the year-round residents in areas where the climate reduces the number of insects during late autumn and winter must have a means of obtaining enough food for survival. Starlings have been known to follow cows as their hooves kick up insects from the soil, but in wintery months when frost forces insects deeper into the soil, following the cows would seem to be futile. But pigs will root (use their noses to dig up dirt) to find food. By rooting, the pigs also make many insects available at the surface that live down in the soil. In the autumn and winter, the pigs root deep enough to bring insects to the surface.

An observation by William Shields of starlings following pigs in a pen is the basis for this study. To date, no observation of this nature has been published. Perhaps by rooting, the pigs stir up enough insects for the starlings to eat. What I propose to do is find out if the starlings follow the pigs for food as it is assumed they do cows. Ideally, it would be profitable to discover whether this behavior is learned or innate, a discovery which would disclose much about the starling's adaptability. But the method for making this discovery would require hand-raising starlings from hatching in an isolated environment, a process which is out of the time limit of this study. The initial study, however, will give enough background information to make any further research feasible.

Understanding this foraging behavior of starlings will allow the people involved in the management of the starling population to have one more tool to work with. Perhaps farmers could discourage starlings from roosting near farms by making livestock less accessible to the birds.

Therefore, from a practical point of view, understanding more about starlings will help prevent them from being nuisances. Starling populations that interfere with aircraft at airports, that cause sanitation problems in cities, and that annoy farmers throughout the United States must be dealt with. And from a behavioral point of view, learning more about the starling will aid us in understanding its amazingly rapid spread throughout the country and also help us prevent the starling from threatening other bird species native to this country.

Procedure

An in-depth lierature search must be undertaken to find out what exactly is known about starlings. A condensed life history of starlings will be written to give the reader an overview of their life cycle, habits, etc. This life history will be compiled from the literature read. Any previous studies on foraging behavior will be looked at closely for successful and unsuccessful methodologies. The experimentation will be conducted in three phases of observation: (1) starlings foraging in flocks--in order to study the behavior of starlings without other animals present (control group); (2) starlings foraging with cows--in order to compare this data with that of phase three; (3) starlings foraging with pigs. The original observation of starlings foraging with pigs in Ohio, made by William Shields, Ph.D. candidate at Ohio State University, was made at Wilmington, Ohio. Therefore, assuming that this is a likely place to observe this behavior again, I will return to Wilmington for phase 3. There are cow farms also in this is area; therefore, phase 2 will also be conducted near the Wilmington area. Phase 1 will be done near Columbus for convenience of transportation, a location which will not effect the results.

Once all observations are completed, the data will be compiled and studied.

The schedule is as follows: phase 1 will be conducted in early October; approximately 20 hours of observation time are needed. Phase 2 will be conducted in late October through mid-November; approximately 40 hours of observation will be needed for this phase. And phase 3 will be conducted in November and early January, occupying approximately 40 hours of observation time. The observation peroids of the different phases will overlap because the time periods that the behaviors occur overlap. When studying any wild animal, one must also be aware that the researchers must conform to the animal's schedule and not vice versa. The availability of opportunities to observe these three phases will determine any adjustments of the schedule. All three phases and the data study will be completed by Winter quarter, 1978.

Qualifications

As a student in Wildlife Management, I have completed many courses in zoology, but those most pertinent to this study are ornithology, ecology, and vertebrate zoology. During my employment as Intern for the Toledo Metropolitan Park District, I spent many hours doing field observations, which familiarized me with the problems related to such work. My interest in this project has developed from my curiosity about the behavior of starlings with pigs. I hope to conduct research as part of my career in the future, and this opportunity to do just that while still under supervision is one of the most important learning experiences I will encounter in my course work.

Because William Shields made the original observation of the starlings with pigs, I will work closely with him on the logistics of the study. Joel Schwankl, a student who graduated in animal behavior, will assist me in my data collection. Dr. T.C. Grubb has consented to act as my faculty advisor.

Discussion

This type of behavioral study is frequently conducted in animal-related fields, but it has never been done concerning this particular starling behavior. The major obstacle of this study will be to observe the starlings in each phase long enough to be able to draw conclusions from the data. But once a location is found with a population of starlings in the area or with an area frequented by the birds, this obstacle should be overcome.

Until all data is compiled and reviewed, there is some uncertainty as to what we may gather. But any evidence will tell us something about the starling we did not know before.

Authorization

From a practical stand-point, the starling has become a nuisance, and it is important to find ways to control it. From an animal behavior stand-point, the starling is a fascinating bird because of the rapid spread it has made across the United States and because of its ability to overcome many of nature's obstacles. Its unique ability to adapt and thrive makes the starling a prime subject for study.

By studying the foraging behavior of starlings, I anticipate that the chance of someone finding successful control methods is increased and that something new will be learned. A study as basic as this one is the necessary building block on which to support further understanding of nature's complexities. Allowing this research to be conducted will generate learning in an area yet unexplored in the life cycle of the starling.

Barbara Walinski

Barbara L. Walinski

17 Curl Dr.
Columbus, OH 43210
December 2, 1977

Robert E. Henne, Secretary
School of Natural Resources
Ohio State University
2120 Fyffe Road
Columbus, OH 43210

Dear Dr. Henne:

I am submitting this letter to report on the progress made concerning the study of the foraging behavior of the starling (*Sturnus vulgaris*).

Studying any aspect of the starling's life cycle is crucial to understanding how to control its populations. With the starling becoming more and more of a pest in cities and on farms, the management of its populations is necessary. Whereas the physiology of the starling is well understood, many aspects of its behavior are yet unstudied. The observation of starlings following pigs was only recently made; no record of such an observation has ever been published. I have proposed to study this particular foraging behavior of the starling in the hope of expanding what is known about the bird, and of adding more information for successful management of its populations. Although the objective of this study does not include devising a management plan, the information I hope to find may provide the details managers need to do so.

The starling is largely an insectivorous bird. Starlings have been known to follow cows as they kick up insects from the soil, but in cold climates, where insects live deeper in the soil, following cows would be seemingly unproductive for the birds. Pigs, however, will root (dig up dirt with their noses) to find food. By rooting, pigs dig deep enough into the soil to reach insects during the cold seasons. This availability of insects from pigs rooting is probably the reason for the starlings following them, especially for the year-round resident birds in the autumn and winter months.

The objective of this study, to determine the reason for starlings following pigs (to determine if they are optimally foraging), will mainly be accomplished through observation. Detailed data will be collected in three phases: (1) Starlings foraging in flocks, (2) starlings foraging with cows, and (3) starlings foraging with pigs. Phase 1 will be the control group; phase 2 will be used as a comparison with phase 3. Samples will also be collected of the soils the starlings feed from in each phase, and an inventory of the insects present will be made. Stomach contents of starlings will also be taken to determine what the birds are eating. The observation sites are located in Wilmington, Ohio (where the original observation was made of starlings with pigs) and in Columbus, Ohio.

All this information, in addition to what is currently known about the starling, could aid managers in revising present population-management techniques to make them more effective, especially in farm communities.

In studying animal behavior, one must not unconciously bias data by predetermining what one expects to find. In other words, no conclusions can be drawn prior to analysis of the results without the potential of invalidating the data taken. Therefore, what this study will find cannot now be assessed in any detail until all data is collected. However, whatever is learned from the results will be new information because this foraging behavior of starlings has not previously been recorded. Whatever we find will be added information to what is presently known about the starling's behavior.

In the beginniing, I had been prevented from making the amount of progress I had hoped to make. In both Wilmington and Columbus, flocks of starlings had been found, but they were mainly huddled in roosts in trees and not foraging on the ground. Because of this problem, much of my initial time spent in the field had been in search of good locations to collect data. A journal is being kept of all flocks seen, where they were and what they were doing when seen. This lull in being able to do field work did, however, allow time for the literature search. Although not every published source has been explored, I have completed the research on the life history of the starling. As for the literature search, only those publications on the optimal foraging theory and some with methodologies that pertain to this study are left to explore.

The first few observations were used to better organize the technique used to collect data. I found it to be very important to have all data sheets arranged in a convenient manner in order to facilitate rapid data-collection (birds move fast).

I have encountered one problem that I cannot correct: at this time of year (autumn), there are migratory flocks of starlings in the area as well as resident flocks, and neither can be distinguished from the other. It is not known whether this foraging behavior with pigs is learned or innate; if it is innate there will be no problems, but if it is learned, then the migratory flocks would influence the data. As it is, migratory flocks could influence the data because their behavior would deviate from the normal behavior of those resident birds that commonly follow the pigs. The resident birds would have learned to follow the pigs for food in winter, but the migratory birds would not. The data taken from observing migratory flocks would probably be different, but because I have no idea what the data should be like, there is no way to recognize this "different" data. Since nothing can be done to distinquish the flocks, all that I can do is mention this fact in the final report. Perhaps in future studies, a technique could be found to eliminate this variable.

I have become aware of many details that must be incorporated into the study so as not to influence the results. Such information includes the following: the time of day, because a representative cross-section of foraging behavior throughout the day must be taken, i.e. not only at dawn; the type of substrate on which the birds are feeding; and other species of birds that may be feeding with the starlings. Care had initially been taken to record weather conditions, the location, inter- and intra-individual distances, etc. at the time of observation.

What has been found concerning the feeding habits of starlings is that they will eat grain and other vegetative matter when the insects are not available, but the starlings seem to search for this food in barnyards as opposed to non-barnyard locations. This assumption that starlings "prefer" barnyards is not conclusive, however. It also appears, from carefully watching what the birds eat and the substrates they feed on, that the starlings may not be seeking the insects as much as I had originally assumed. The starlings often feed on grain that has been dispursed on the ground. This assumption requires more research before it can be proven. From the information collected in the life history of starlings, other studies show that during the winter, starlings generally eat 30 percent insects and 70 percent vegetative matter. I will use the stomach content analysis to obtain my own percentages.

From the time I have spent in the field, I have noticed increased foraging behavior of the starlings as wintery weather sets in; the birds must consume more to meet the requirements of increased metabolic rates. For this reason, I will try to collect data on into January. I have not collected enough data on starlings while foraging alone; but because many opportunities exist at present to observe the birds foraging with pigs, I will concentrate my efforts on phase 3. I hope to find a location where I could observe starlings foraging alone by January; if I cannot, the schedule may have to be revised but I see no need to make a revision at present.

I have found that all three phases can be conducted simultaneously, therefore I will be observing all three phases for the remainder of December and into January, but with emphasis on phase 3. Then, as each phase is completed, its results will be studied and analyzed. When all three phases have been completed, the final result will be only a matter of comparing the three, with the bulk of the analysis having been done to hasten the process.

The soil samples and stomach contents will be collected randomly during the study. The analysis of the soil and stomach contents must be done within a day of the collection for accuracy. Percentages will be taken of the amount of insect matter and vegetative (grain) matter found in the stomachs and, if possible, also in the soil samples. A comparison will be made of what can be eaten by the starlings and what actually is eaten, for each phase if possible. I have yet, however, to get the permission from a farmer to take starlings on private property.

The results from each observation phase, the soil inventories, and the stomach-content analyses will be compiled and studied. I will prepare the final results of the study in a final report and will submit it to you by Winter quarter, 1978. You will notice that the journal does not accompany this report as you had requested; I will still be collecting data into mid-December, and for this reason I cannot submit the journal at present.

Sincerely yours,

Barbara L. Walinski

Barbara L. Walinski

1986 Indianola Avenue
Apt. B
Columbus, Ohio 43201
May 8, 1978

Dr. Robert E. Henne, Secretary
School of Natural Resources
The Ohio State University
2120 Fyffe Road
Columbus, Ohio 43210

Dear Dr. Henne:

I am submitting the accompanying report as partial fulfillment of the requirements for the Honors Program. The report, entitled A Preliminary Study of the Foraging Behavior of Starlings in Central Ohio Farm Areas, explains the results of this study that intends to provide additional information to aid the wildlife manager in controlling starlings in these farm communities. I have approached this subject from a feeding efficiency standpoint, and I have also included suggestions for methodologies of any further research conducted on this subject.

The original observation that lead to this study was made by Mr. William M. Shields. I wish to acknowledge the assistance Mr. Shields and Mr. Joel Schwankl have given me.

I sincerely hope this report will meet with your approval.

Respectfully yours,

Barbara Walinski

Barbara L. Walinski